angle dependence of the color reproducibility, the source direct multi-pixel type is advantageous because the flexibility of combination of display signal voltages which are to be supplied to two or more sub-pixels included in a pixel is high.

[0013] On the other hand, a liquid crystal display device of the source direct multi-pixel type has a problem of poor mass productivity. This is attributed to a fact that, for example, a method disclosed in Patent Document 3 which uses spare wires cannot substantially repair disconnection of a source bus line.

[0014] ~~The~~Embodiments of the present invention ~~was~~are conceived for the purpose of solving at least one of the above-described problems. ~~The objects~~Embodiments of the present invention include providing a liquid crystal display device of the source direct multi-pixel type which is capable of repairing disconnection of a source bus line and/or providing a liquid crystal display device having a multi-pixel configuration which is capable of reducing the viewing angle dependence of the color reproducibility.

SOLUTION TO PROBLEM

[0015] A liquid crystal display device according to an ~~embodiment~~aspect of the present invention includes: a plurality of pixels arranged in a matrix of rows and columns, each of the plurality of pixels including a first sub-pixel and a second

Claims

1. A liquid crystal display device, comprising:

a plurality of pixels arranged in a matrix of rows and columns, each of the plurality of pixels including a first sub-pixel and a second sub-pixel;

a first TFT and a second TFT which are associated with each of the plurality of pixels;

a first source bus line connected to the first sub-pixel via the first TFT and a second source bus line connected to the second sub-pixel via the second TFT;

a spare wire which is electrically connectable with the first source bus line and/or the second source bus line; and

a control circuit configured to receive an input display signal that is indicative of grayscale levels which are to be exhibited by the plurality of pixels, generate a first display signal voltage and a second display signal voltage which are to be supplied to the first sub-pixel and the second sub-pixel of each of the plurality of pixels, and output the generated first and second display signal voltages to the first source bus line and the second source bus line, respectively,

wherein when the first source bus line or the second source bus line which is associated with a pixel of one column is electrically connected with the spare wire, the control circuit is capable of controlling amplitudes of oscillation of the first display signal voltage and the second display signal voltage output to the first source bus line and the second source bus line associated with the pixel of the one column so as to be smaller than that achieved when the first source bus line or the second source bus line associated with the pixel of the one column is not electrically connected with the spare wire.

2. The liquid crystal display device of claim 1, wherein when the first source bus line or the second source bus line which is associated with the pixel of the one column is electrically connected with the spare wire, the control circuit is capable of controlling the amplitudes of the oscillation of the first display signal voltage and the second display signal voltage output to the first source bus line and the second source bus line associated with the pixel of the one column so as to be zero.

3. The liquid crystal display device of claim 1, wherein

the plurality of pixels form a plurality of color display pixels, each of the plurality of color display pixels including three or more pixels which exhibit different colors, and

when the first source bus line or the second source bus line which is associated with the pixel of the one column is electrically connected with the spare wire, the control circuit is capable of changing the amplitude of the oscillation of the first display signal voltage or the second display signal voltage according to a color which is to be exhibited by the pixel of the one column.

4. The liquid crystal display device of claim 1, wherein

the plurality of pixels form a plurality of color display pixels, each of the plurality of color display pixels including three or more pixels which exhibit different colors, and

the control circuit is capable of generating a first display signal voltage and a second display signal voltage that are to be supplied to the first sub-pixel and the second sub-pixel of an arbitrary one of the plurality of pixels based on a grayscale level to be exhibited by the arbitrary pixel and grayscale levels to be exhibited by two or more remaining pixels included in a color display pixel to which the arbitrary pixel belongs that are indicated by the input display signal, and outputting the generated first and second display signal voltages to the first source bus line and the second source bus line, respectively.

5. The liquid crystal display device of claim 4, wherein for one grayscale level which is to be exhibited by the arbitrary pixel, the control circuit is capable of generating the first display signal voltage and the second display signal voltage that have two or more different absolute values according to the grayscale levels to be exhibited by the two or more remaining pixels.

6. The liquid crystal display device of claim 4, wherein

the first source bus line and the second source bus line extend in the column direction,

in each of the plurality of pixels, the first sub-pixel and the second sub-pixel are arranged in the column direction, and

a polarity of the first display signal voltage supplied from the first source bus line and a polarity of the second display signal voltage supplied from the second source bus line are each constant within a frame.

7. The liquid crystal display device of claim 6, wherein the polarity of the first display signal voltage supplied from the first source bus line and the polarity of the second display signal voltage supplied from the second source bus line are opposite to each other in a frame.

8. The liquid crystal display device of claim 6, wherein

some of the plurality of pixels which are arranged in the column direction are to exhibit a same color, and

two sub-pixels which belong to two pixels adjacent to each other in the column direction and which are electrically connected to the first source bus line are adjacent to each other in the column direction.

9. The liquid crystal display device of claim 1, wherein the first TFT and the second TFT include a semiconductor oxide layer as an active layer, the semiconductor oxide layer including an In—Ga—Zn—O semiconductor.

10. The liquid crystal display device of claim 9, wherein the In—Ga—Zn—O semiconductor includes a crystalline portion.

CLAIMS

1. A liquid crystal display device, comprising:

a plurality of pixels arranged in a matrix of rows and columns, each of the plurality of pixels including a first sub-pixel and a second sub-pixel;

a first TFT and a second TFT which are associated with each of the plurality of pixels;

a first source bus line connected to the first sub-pixel via the first TFT and a second source bus line connected to the second sub-pixel via the second TFT;

a spare wire which is electrically connectable with the first source bus line and/or the second source bus line; and

a control circuit configured to receive an input display signal that is indicative of grayscale levels which are to be exhibited by the plurality of pixels, generate a first display signal voltage and a second display signal voltage which are to be supplied to the first sub-pixel and the second sub-pixel of each of the plurality of pixels, and output the generated first and second display signal voltages to the first source bus line and the second source bus line, respectively,

wherein when the first source bus line or the second source bus line which is associated with a pixel of one column is electrically connected with the spare wire, the

control circuit is capable of controlling amplitudes of oscillation of the first display signal voltage and the second display signal voltage output to the first source bus line and the second source bus line associated with the pixel of the one column so as to be smaller than that achieved when the first source bus line or the second source bus line associated with the pixel of the one column is not electrically connected with the spare wire.

2. The liquid crystal display device of claim 1, wherein when the first source bus line or the second source bus line which is associated with the pixel of the one column is electrically connected with the spare wire, the control circuit is capable of controlling the amplitudes of the oscillation of the first display signal voltage and the second display signal voltage output to the first source bus line and the second source bus line associated with the pixel of the one column so as to be zero.

3. The liquid crystal display device of claim 1 or 2, wherein

the plurality of pixels form a plurality of color display pixels, each of the plurality of color display pixels including three or more pixels which exhibit different colors, and

when the first source bus line or the second source bus

line which is associated with the pixel of the one column is electrically connected with the spare wire, the control circuit is capable of changing the amplitude of the oscillation of the first display signal voltage or the second display signal voltage according to a color which is to be exhibited by the pixel of the one column.

4. The liquid crystal display device of claim 1 or 2, wherein

the plurality of pixels form a plurality of color display pixels, each of the plurality of color display pixels including three or more pixels which exhibit different colors, and

the control circuit is capable of generating a first display signal voltage and a second display signal voltage that are to be supplied to the first sub-pixel and the second sub-pixel of an arbitrary one of the plurality of pixels based on a grayscale level to be exhibited by the arbitrary pixel and grayscale levels to be exhibited by two or more remaining pixels included in a color display pixel to which the arbitrary pixel belongs that are indicated by the input display signal, and outputting the generated first and second display signal voltages to the first source bus line and the second source bus line, respectively.

5. The liquid crystal display device of claim 4, wherein for one grayscale level which is to be exhibited by the arbitrary pixel, the control circuit is capable of generating the first display signal voltage and the second display signal voltage that have two or more different absolute values according to the grayscale levels to be exhibited by the two or more remaining pixels.

6. The liquid crystal display device of claim 4 or 5, wherein

the first source bus line and the second source bus line extend in the column direction,

in each of the plurality of pixels, the first sub-pixel and the second sub-pixel are arranged in the column direction, and

a polarity of the first display signal voltage supplied from the first source bus line and a polarity of the second display signal voltage supplied from the second source bus line are each constant within a frame.

7. The liquid crystal display device of claim 6, wherein the polarity of the first display signal voltage supplied from the first source bus line and the polarity of the second display signal voltage supplied from the second source bus line are opposite to each other in a frame.

8. The liquid crystal display device of claim 6 or 7, wherein

some of the plurality of pixels which are arranged in the column direction are to exhibit a same color, and

two sub-pixels which belong to two pixels adjacent to each other in the column direction and which are electrically connected to the first source bus line are adjacent to each other in the column direction.

9. The liquid crystal display device of any of claims 1 to 8, wherein the first TFT and the second TFT include a semiconductor oxide layer as an active layer, the semiconductor oxide layer including an In-Ga-Zn-O semiconductor.

10. The liquid crystal display device of claim 9, wherein the In-Ga-Zn-O semiconductor includes crystalline portion.